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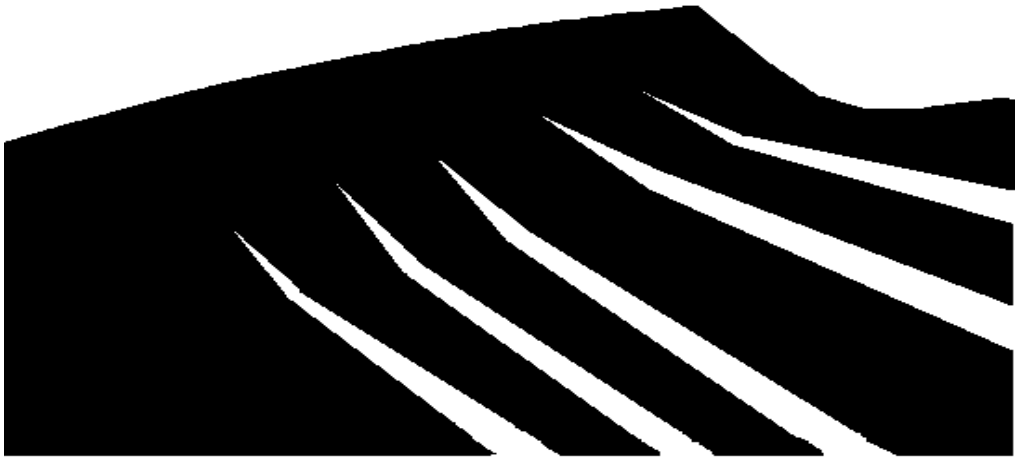
PETROGRAPHY PROCEDURE

LOS ALAMOS

QUALITY PROGRAM



APPROVAL FOR RELEASE	
D. VANIMAN - PREPARER Signature on file	DATE Date on file
D. VANIMAN - PRINCIPAL INVESTIGATOR Signature on file	DATE Date on file
M. J. CLEVENGER - QUALITY ASSURANCE PROJECT LEADER Signature on file	DATE Date on file

Los Alamos
Yucca Mountain Site Characterization Project

HISTORY OF REVISION

REVISION NO.	EFFECTIVE DATE	PAGES REVISED	REASON FOR CHANGE
R0	3/5/79	N/A	Not applicable
R1	8/15/79	1	Change in TPO and change from TWS-G6-1/79-24 to TWS-G6-DP-03.
R2	10/16/88	All	Expanded format to include quality assurance section and change from TWS-G6-DP-03 to TWS-EES-DP-03.
R3	2/20/90	All	Modified to fit new DP format; title change from "Nevada Test Site Core Petrography Procedure" to Petrography Procedure"
R4	3/29/94	All	Modified to fit new DP format and allow for image analysis.
R5	3/21/97	All	Modified to fit new DP format and allow for microautoradiography.

PETROGRAPHY PROCEDURE

1.0 PURPOSE

The purposes of this procedure are (1) to standardize the petrographic descriptions used within mineralogy-petrology tasks through use of a set of primary reference books and (2) to assure adequate documentation of petrographic descriptions.

2.0 SCOPE

This procedure may be used for any petrographic descriptions made by standard optical methods (i.e., unaided visual observation, hand lens, binocular microscope, petrographic microscope) for the Yucca Mountain Site Characterization Project.

3.0 APPLICABLE DOCUMENTS AND REFERENCES

LANL-YMP-QP-02.7, Personnel Training
LANL-YMP-QP-3.5, Documenting Scientific Investigations
LANL-EES-DP-101, Sample/Specimen Collection, Identification, and Control for Mineralogy-Petrology Studies
LANL-EES-DP-102, Procedure for Determination of Volume Constituents in Thin Sections of Rocks
LANL-EES-DP-130, Geologic Sample Preparation
AP-16.1Q, Performance/Deficiency Reporting
AP-16.2Q, Corrective Action and Stop Work

Published reference works applicable to this procedure are:

Bates, R.L., and Jackson, J.A., (editors) (1980) Glossary of Geology. American Geological Institute, Washington, D.C., 751 pp, or subsequent editions.
Bloss, F.D., (1981) The spindle stage: Principles and practice. Cambridge Univ. Press, NY, 340 pp.
Emmons, R.C., (1964) The universal stage. Geol. Soc. Amer. Memoir 8, 205 pp.
Ross, C.S., and Smith, R.L., (1961) Ash-flow tuffs: Their origin, geologic relations and identification. U.S. Geol. Survey Prof. Paper 366, 81 pp.
Smith, R.L., (1960) Zones and zonal variations in welded ash flows. U.S. Geol. Survey Prof. Paper 354-F, p. 149-159.
Williams, H., Turner, F.J., and Gilbert, C.M., (1954) Petrography. W.H., Freeman and Co., San Francisco, 406 pp.

4.0 DEFINITIONS

4.1 Petrographic microscope-a microscope equipped with a polarizer and an analyzer, capable of creating optical interference effects.

4.2 Petrography-the description and classification of rocks.

5.0 RESPONSIBILITIES

The following personnel are responsible for the activities identified in section 6.0 of this procedure.

- The Principal Investigator (PI)
- Users of this Procedure

6.0 PROCEDURE

The use of this procedure must be controlled as follows:

- If this procedure cannot be implemented as written, YMP personnel should notify appropriate supervision. If it is determined that a portion of the work cannot be accomplished as described in this QP, or would result in an undesirable situation, that portion of the work will be stopped and not resumed until this procedure is modified, replaced by a new document, or the current work practice is documented in accordance with QP-03.5, Section 6.1.6.
- Employees may use copies of this procedure printed from the controlled document electronic file; however, employees are responsible for assuring that the correct revision of this procedure is used.
- When this procedure becomes obsolete or superseded, it must be destroyed or marked “superseded” to ensure that this document is not used to perform work.

The PI or the individual analyst uses this procedure as necessary to obtain petrographic data. Unaided visual observation, hand-lens observation, or binocular-microscope observation can be one-step procedures. In the case of petrographic-microscope observations, thin sections must first be prepared. Either the PI or the individual analyst may submit samples for thin sectioning.

Petrographic analysis may include mineral identification, textural and microfabric description, and porosity estimation. There are many methods of porosity estimation (e.g., stained-epoxy point-counting or image analysis). Some of these methods use microbeam as well as optical instruments. The analyst should state on his notebook which technique of porosity estimation is being used, as well as any applicable microbeam detailed procedures.

6.1 Principle

The principles of petrographic analysis are learned through college-level course work. The standard reference for this procedure is Williams et al. (1954). Use of other references and current literature research may be required for special petrographic problems.

6.2 Equipment and Hardware/Software

Petrographic descriptions may be obtained by unaided visual observations, by hand lens, by binocular microscope, or by petrographic microscope. Any brand or model of lens or optical microscope may be used for petrographic analysis. Petrographic microscopes with appropriate stage and optical elements must be used for U-stage studies (Emmons, 1964). No computer hardware or software is involved in routine optical petrographic data collection, although a database will be used for sample tracking (DP-101). Advanced optical analysis may require the use of some commercial software (e.g., Bloss, 1981). In addition, electronic databases may be used for compiling and analyzing quantitative petrographic data (see DP-102), and image-analysis software may be used for a variety of quantitative petrographic analyses.

6.2.1 Malfunctions

Any equipment malfunctions in petrography using optical microscopes will be easily recognized and corrected (e.g., light-bulb replacement).

6.2.2 Safety Considerations

If optical petrography is being performed for microautoradiography, the user should follow the SOP for microautoradiography that is kept with the microscope used for such applications.

6.2.3 Special Handling

Refer to the SOP for microautoradiography for handling, storage, and transport restrictions.

6.3 Preparatory Verification

6.3.1 Hold Points

This is a single-step procedure without hold points, with the exception that petrographic analysis of thin sections can not proceed until thin sections are prepared. If modal estimates or point counts (see DP-102) are entered into a database, the person entering the data should cross-check the entered data against the original notebook entries.

6.3.2 Calibration

Calibration is not required for the optical instruments covered by this procedure. Magnification scales may be acceptably quantified by the use of commercial-grade stage micrometers or other appropriate scales. Where precise image measurements are required, it is recommended that the researcher use a technique such as image analysis.

6.3.3 Environmental Controls

No controlled environments are necessary for this procedure.

6.4 Control of Samples

Sample labeling and control is described in procedure DP-101.

6.5 Implementing Procedure

Step One: Prepare or acquire thin sections, if needed. Thin sections are prepared following DP-130.

Step Two: Complete petrographic analysis. Petrographic descriptions are either descriptive or quantitative; both are somewhat subjective, and no two anlaysts will generate identical descriptions. The recorded information will be traceable to a specific location in the field or to a specific sample in the laboratory to allow other petrographers to review the description. Photographs and drawings, appropriately keyed to specific field locations or samples, may be used to support petrographic descriptions. Quantitative petrographic analysis includes, but is not limited to, point counting and size measurement. Point counting is described in procedure DP-102. Coarse features may be measured by any standard scale, with metric units preferred; microscopic features may be measured by ocular scale. These scales are used for approximate and relative size classification only; thus calibration of the scales is not required. Examples of petrographic descriptions appropriate to this procedure can be found in the figure captions of Williams et al. (1954). Advanced optical methods (e.g., U-stage or spindle-stage studies) are covered by Emmons (1964) and Bloss (1981), although other references may be used. A standard reference for petrographic terms is Bates and Jackson (1980) and subsequent editions. Examples of additional terms used for textural features of silicic volcanic rocks are described in Ross and Smith (1961) and Smith (1960). For special applications, such as image analysis, or goniometry to determine angles between crystal faces, several methods are possible. The analyst should indicate in his notebook which method is used, with explanations and clarifications as appropriate.

6.6 Data Acquisition and Reduction

Petrographic descriptions will be recorded in an appropriate notebook, maintained and reviewed as provided in QP-03.5. Quantitative or semiquantitative data may also be put into an electronic database for data analysis.

6.7 Potential Sources of Errors, and Uncertainty

The only significant source of uncertainty and error in optical petrographic description is mineral misidentification. Analysts are advised to refrain from making optical mineral identifications where the minerals are too fine-grained for adequate analysis or where the optical properties are ambiguous. Where mineral identifications are ventured without certain optical identification, the notebook entry may be marked as "possible," "?," or otherwise queried. Uncertainties and errors in quantitative petrographic analyses are described in the relevant procedure DP-102. Any special optical petrographic methods not covered by this procedure shall be documented in a controlled laboratory notebook, following the requirements of QP-03.5, or in a detailed procedure. In image analysis, errors in porosity estimation are often difficult to estimate; therefore analysts are encouraged to use more than one method of porosity estimation. Any deficiencies requiring corrective action will be handled according to AP-16.1Q and AP-16.2Q.

7.0 RECORDS

Petrographic descriptions are recorded in ink in a controlled laboratory or field notebook. Photographs may be attached as part of the description, and sketches may be used. It is advisable to mark or describe the scale of any photograph or sketch. Notebook maintenance and review following QP-03.5 is required to determine that petrographic description activities have been adequately accomplished.

8.0 ACCEPTANCE CRITERIA

Petrographic data in notebooks will be reviewed for acceptability as outlined in QP-03.5. Rejection of certain parts of a petrographic analysis may be made by the same analyst or by another analyst based on reanalysis of the same sample; in such a case, the cause for the rejection should be described in the reanalysis and referred back to the original analysis. Since a wide latitude is possible in descriptive parameters, such rejections should be rare. Rejections must be based on demonstratably incorrect data in the original analysis, not on differences of interpretation between researchers. The likeliest cause of a rejection is mineral misidentification based on optical properties; where mineral identity is optically ambiguous and important to the sample description, confirmation of mineral identity should be sought through electron microbeam analysis and/or X-ray diffraction analysis.

9.0 TRAINING

Completion of at least one college-level course that covers the topics of optical mineralogy and petrography and training "Read Only" to DP-101 is required. Training for this DP is "Read Only". All training will be documented pursuant to QP-02.7.

10.0 ATTACHMENTS

N/A